BULLETIN

OF THE

Society for the Promotion of Engineering Education

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EDITORIAL.

Improvements in the Bulletin.—This number completes the second volume of the BULLETIN of the Society. The first volume was experimental in character, but, in spite of its crudeness, it demonstrated its value as a means of communication among the members. It is now time to increase its value by making it the vehicle of publication of notable articles on technical education in addition to the papers presented at the annual meetings of the Society. Suggestions as to improvement will be cordially welcomed by the Publication Committee. Loyal members can do the Society good service in this particular direction at this time.

The Boston Meeting.—In this number of the BULLETIN a number of abstracts of convention papers will be found. These indicate in a general way what may be expected at the meeting. The program is of such a nature that definite results in improvement of instructional methods may be confidently expected. It will be noted that the topics are all of an extremely practical nature. Teaching physics to engineering students, improving the equipment of instructors for their work, increasing the efficiency of administration, comparing notes on laboratory equipment and methods, are among the topics for consideration. This kind of a program not only conduces to definiteness but it brings out the people who like definiteness. The Program Committee has done its part, the Boston local committee has made ample provision for the material needs of the members and it only remains for the members to get to Boston and to take an active part in the proceedings. The

Society meets at the same time as the American Institute of Electrical Engineers which has more than 7,000 members. By coöperation between the two societies our members will enjoy many advantages which they would miss if meeting alone.

New Members.—A long list of applicants for admission is printed in this issue. This list will suggest to all of our members the desirability of extending invitations to desirable persons to join at the time of the annual meeting. We shall pass the 1,200 mark at this meeting if each member will coöperate with the Membership Committee.

CHANGES IN CONSTITUTION AND BY-LAWS.

In order to comply with the regulations of the Post-office Department it will be necessary to make certain changes in the Constitution of the Society. After a long correspondence with the Department in which the third assistant postmaster general did everything in his power to assist us in meeting the requirements of the law the following modifications of the present Constitution were agreed to by the Council of the Society. Minor changes in wording have been made since the Council took action but the principle is the same as was approved in letter ballot. This action will come up for approval at the Boston meeting.

Article 6 to be altered as follows:

6. *Fees and Dues.* The admission fee, which shall also include the first year's dues, shall be *four dollars* ($4.00).

The annual dues, which shall include the subscription price of the BULLETIN provided for in Article 8 shall be *four dollars* ($4.00), payable at the time of the annual meeting.

Then follow as in the remainder of Article 6.

Article 8 to be altered as follows:

8. *Publications.* The publications of the Society shall include an annual volume of Proceedings to be published and distributed to the membership as soon as possible after the annual meeting; and a monthly Bulletin to be published from September to June inclusive.

Alter the sixth by-law by inserting in the fourth line between the words "the" and "Proceedings," the words "monthly Bulletin and the," and by adding at the end the following sentence: "The subscription price for the BULLETIN shall be one dollar ($1.00)."

President Raymond also suggests that Article 7 of the Constitution be amended to read:

"There shall be an annual meeting at such time and place as the Council may determine." It is always possible for the meeting to be held in connection with that of any other society and as this article has long been without force and as the original reason for its adoption does not now exist it would seem wise to make the Constitution conform to present practice. This matter is now before the Council by letter ballot and will be brought up for action at the annual meeting if two thirds of the members of that body approve of it.

APPLICANTS FOR ADMISSION, TO BE ELECTED AT THE BOSTON MEETING.

BABBITT, A. B., Head of Department of Drawing and Design, Wentworth Institute, Boston, Mass. 1912

BERARD, S. J., Instructor in Machine Design, Sheffield Scientific School, Yale University, New Haven, Conn. 1912

BISHOP, C. T., Assistant Professor of Civil Engineering, Sheffield Scientific School, Yale University, New Haven, Conn. 1912

BOOMSLITER, G. P., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1912

CHASE, C. F., Assistant in Farm Mechanics, Kansas State Agricultural College, Manhattan, Kans. 1912

CHILDS, A. T., Assistant Professor of Electrical Engineering, University of Maine, Orono, Me. 1912

COGHILL, WM. H., Instructor in Mining and Metallurgy, Northwestern University, Evanston, Ill. 1912

COLEMAN, J. F., Consulting Engineer, 920 Hibernia Bldg., New Orleans, La. 1912

CONKLING, L. D., Associate Professor of Civil Engineering, Lehigh University, South Bethlehem, Pa. 1912

CONNER, S. L., Instructor in Railroad Engineering, Tufts College, Tufts College, Mass. 1912

CORBETT, L. J., Associate Professor of Electrical Engineering, University of Idaho, Moscow, Ida. 1912

DESCHWEINITZ, P. B., Professor of Machine Design, Lehigh University, South Bethlehem, Pa. 1912

DILLINGHAM, ALEXANDER, Instructor of Mathematics, Tufts College, Tufts College, Mass. 1912

DUFF, C. M., Instructor in Engineering Mathematics, University of Colorado, Boulder, Colo. 1912

DWIGHT, H. B., Professor of Mechanical Engineering, University of Oklahoma, Norman, Okla. 1912

ELLIS, FREDERICK, Instructor in Wood Working, University of Illinois, Urbana, Ill. 1912

FITTERER, J. C., Professor of Civil and Irrigation Engineering, University of Wyoming, Laramie, Wyo. 1912

GILMORE, L. H., Professor of Physics, Throop Polytechnic Institute, Pasadena, Calif. 1912

GREEN, CHAS. W., Instructor in Electrical Engineering, Massachusetts Institute of Technology, Boston, Mass. 1912

GRUMBEIN, J. B., Assistant Professor of Mechanical Engineering, West Virginia University, Morgantown, W. Va. 1912

HOWE, C. D., Professor of Civil Engineering, Dalhousie University, Halifax, N. S. 1912

HUTCHINS, R. E., Instructor in Civil Engineering, Brown University, Providence, R. I. 1912

JAMES, L. V., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. 1912

KENISON, ERVIN, Assistant Professor of Drawing and Descriptive Geometry, Massachusetts Institute of Technology, Boston, Mass. 1912

LAPHAM, J. R., Assistant in Civil Engineering, Pennsylvania State College, State College, Pa. 1912

LYON, W. V., Instructor in Electrical Engineering, Massachusetts Institute of Technology, Boston, Mass. 1912

MASON, A. J., Engineer, Chicago Railway Exchange, 5715 Woodlawn Ave., Chicago, Ill. 1912

MILLER, H. W., Associate in General Engineering Drawing, University of Illinois, Urbana, Ill. 1912

MUSTARD, J. H., Works School Instructor, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 1912

PARR, S. W., Professor of Applied Chemistry, University of Illinois, Urbana, Ill. 1912

PERTSCH, J. G. JR., Instructor in Electrical Engineering, Cornell University, Ithaca, N. Y. 1912

POLK, ANDERSON, Associated with The Lowe Brothers Co., of Dayton, O., 10 Elmwood Road, Roland Park, Baltimore, Md. 1912

POND, F. J., Professor of Chemistry and Director of Chemical Laboratory, Stevens Institute of Technology, Hoboken, N. J. 1912
SMALLWOOD, J. C., Associate Professor of Experimental Engineering, Syracuse University, Syracuse, N. Y. 1912
SULLIVAN, GEO. L., Professor of Mechanical Engineering, Santa Clara College, Santa Clara, Calif. 1912
TYRRELL, H. G., Consulting Engineer and Author, 540 Judson Ave., Evanston, Ill. 1912
WILLSON, F. G., Instructor in Electrical Engineering, University of Illinois, Urbana, Ill. 1912

LETTERS TO THE EDITOR.

EDITOR S. P. E. E. BULLETIN,

Dear Sir: Will you permit one of the younger members of this society to offer a few thoughts and suggestions regarding the work of the Society for the Promotion of Engineering Education?

I take it that the main object of an organization, such as this, is to contribute in a direct and efficient manner to improving men, methods, and equipment, for the teaching of engineering subjects, and the question naturally arises as to the best means of securing this end,—whether it is better secured through the present policy of voluntary contributions to the BULLETIN of the Society, and by specially arranged programs for the annual meetings consisting of papers and discussions, or whether there is not another far more efficient method of work. I believe there is.

There was recently held in Chicago the annual meeting of the American Railway Engineering Association. As is well known, the meetings of this association as well as most of its bulletins are devoted entirely to reports of standing committees and to discussions of the same. The standing committees cover practically every field of railway construction and maintenance, and the personnel of the committees includes not only chief engineers but assistant engineers of various degrees, who are given equal opportunity to take part in the committee work and discussions. These committees gather and analyze the experiences of the entire association

along the particular lines referred to them, institute and carry on investigations of disputed or uncertain points in design and construction, or other practice, and recommend to the association from time to time for adoption, standard rules to be embodied in the Association's "Manual of Standard Practice." To anyone familiar with the results achieved by this organization in its comparatively short life, the method above outlined needs no justification.

To my mind the Society for the Promotion of Engineering Education offers a most excellent opportunity for an application of the same methods, with as satisfactory results. There are many large problems in engineering education pressing for solution. Instead of each institution endeavoring in its own way to find a solution of these problems, why not coöperate directly and efficiently through the Society for the Promotion of Engineering Education? To take for example the work most familiar to the writer, let us have a standing committee on the teaching of structural engineering. Let this committee be composed of a number of practicing bridge and structural engineers, as well as members of the society engaged in teaching this particular subject. Let the committee subdivide into committees on mechanics of materials, bridge design, building design, reinforced concrete, etc., and in this way study the courses in structural engineering as at present offered in our technical schools, investigate the needs and requirements of practicing engineers for structural engineering graduates, and recommend from time to time courses of study in outline and in detail. Let there be other standing committees on other branches of instruction, on methods of registration, requirements for graduation, architecture of engineering schools, and on many other subjects which will occur to anyone giving the matter a little thought. Let the BULLETIN be devoted exclusively (except for individual papers of unusual interest) to progress reports and discussion of the committees. Let the annual meeting be devoted to receiving, discussing, and passing on committee recommendations.

The objection will be raised at once that the work involved will be too great a tax on the time of the members of the Society, and that it will be difficult or impossible to secure proper coöperation. I believe the latter would prove an unjust criticism of the spirit of this society and that the former difficulty would be overcome—first so expanding the number of committees and sub-committees that the actual field to be covered by any one member would be comparatively small, and second by not depending for the membership of committees primarily on heads of departments whose time is more likely to be already fully occupied; there are many capable younger members of the Society who, under an efficient chairman, could be depended on to do effective committee work. No one can rightly question the practicability of the proposed method after a study of the work of the American Railway Engineering Association. Surely the unsolved problems of technical education deserve the application of the most scientific methods to their solution. Then surely the Society for the Promotion of Engineering Education should seriously consider the adoption of this proposed policy.

The above remarks are not written in a spirit of criticism of the past work of the Society, or in ignorance of the good work already done by standing committees, some of them covering to a greater or less extent the subjects mentioned here. It is merely a plea for a broad extension of this sort of work, written with the hope that the coming annual meeting will see fit to take the matter under consideration.

Respectfully,

L. J. TOWNE.

UNIVERSITY OF ILLINOIS,
April 5, 1912.

SECRETARY, S. P. E. E.,

Dear Sir: I should like to supplement my formal discussion* by making a few detached remarks against part of the "Notes" by Professors Franklin and MacNutt.

That "the things in physics which are detached from ex-

* See p. — of this issue.

perience cannot possibly be assimilated by the student except by rote," p. 454, is absolutely untrue—if it has any meaning at all. It is possible to make nearly any experience we please part of his common stock; indeed, it is debatable whether this is not the sum and substance of teaching.

The authors say that the formula $F=kma$ is more rational than $F=ma$. I shall not take advantage of them by questioning what they mean by "rational"; I ask, however, not what it means, but *how it sounds* to say: "unit force, namely five and one half units, produces unit acceleration on unit mass." Unless force is defined without regard to its acceleration effect, the equation $F=kma$ *defines force quantitatively* and must give unit force the value unity, *i. e.*, we must have $k=1$. If force is defined by its deformation effect, k corresponds to modulus of elasticity, m to length, and a to stretch.

Shades of Fourier and Maxwell! Hard it is to be temperate and cool as Cassius, in criticizing the opinion that dimensional formulas are useless and misleading! Perhaps the mention of the words "homogeneous" and "dynamical similitude" may point to the usefulness of dimensions; and, to paraphrase Tait, lengthiness, lengthfulness, and belengthenedness, may indicate attributes not dissociated from unmeasured length. As for "square brackets with capital letters," I have for a dozen years omitted the brackets as trash and used the symbol "$\equiv$," instead of "$=$," to denote qualitative, instead of quantitative, equality.

If the time has come "to stop questioning physical units," it is also time to stop questioning such terms as mechanical equivalent of heat. A rose—a name— etc.

The paragraph "Another Example," p. 459, contains an idea of which the writer foolishly believed himself to be the sole proprietor. Force is not transmissible, cannot be resolved into components, and cannot be superposed unless we deal only with *motion*. To fix the blame for the idea of universal superposition of force, let me quote from an unpublished manuscript.

"Poinsot's *Eléments de Statique* laid the foundation of a

part of the geometry of force vectors, and by its novelty and ingenuity attracted enough attention to cause that novelty and ingenuity to be incorporated into elementary statics. It was by no means a contribution to *physical* mechanics. That statics is still based on the theory of couples is strange—strange, not merely because the theory is unnecessary to statics, but because it fails signally to exhibit the behavior of a material body under stress. The couples and forces of our text books act on sheets of paper or on irregular potato-shaped contours—not on bodies capable of yielding and resisting."

However, in my opinion, postulating "a simple proportional relationship between cause and effect," p. 459, does no good. In deriving a *basic* physical relation $y=f(x)$, it is necessary to prove experimentally that x and y are related, and then to find experimentally the form of the function.

Ibsen said that a well-constituted truth lasts seventeen years. In the same—perhaps Pickwickian—sense it may be said that forty-nine per cent. of our laboratory work is a stupid, criminal waste of time. To set a student at measuring blocks, finding specific gravities, weighing things, pulling springs, reflecting light, watching water boil, etc., etc., and, worst of all, asking him to plot results on "squared paper," kills his interest, stunts his mind, and flattens his chest. Forty-nine per cent. of our laboratory work is gesticulation: it is annoying to those who understand language. One carelessly performed but carefully explained experiment by the teacher is worth more than all the unaimed, slovenly, puttering of a hundred pupils.

R. F. DEIMEL.

STEVENS INSTITUTE,
May 2, 1912.

THE EDITOR, S. P. E. E. BULLETIN,

Dear Sir: The custom of granting one year's leave in seven, with part pay, is getting more common in our colleges, and the question arises what are proper ways for an engineering teacher to employ such a leave of absence.

From casual observation and discussion the writer is aware of differences of opinion on the use of a sabbatical year. Some, on leave, travel for health, pleasure, culture, etc.; some write a book; some enter industrial work; some pursue studies either at home or abroad. Apparently, the year is considered by some as an opportunity to improve themselves, by others, to improve their pocket-books. Granting that no one needs more financial encouragement than the teacher, yet in what light will he appear to the college and to the public if he takes up employment primarily for the remuneration afforded? Is there an ethical side to this question? Have any colleges formulated definite lines of activity for the sabbatical year or restricted their sabbatical men in any way? What causes have brought about this institution?

These and other questions suggest themselves and I would like to see the columns of the BULLETIN thrown open to an exchange of views and facts concerning the sabbatical year.

Very truly yours,

L. H. RITTENHOUSE.

HAVERFORD COLLEGE,
May 5, 1912.

SYMPOSIUM ON ENGINEERING LABORATORIES.

Abstracts of papers to be presented at the twentieth annual meeting of the Society to be held at Boston, Mass., June 26, 27 and 28, 1912. Discussion is invited. Communications may be addressed to the various members in charge of the section meetings, or to the Secretary. The section chairmen are as follows:

Mining Engineering Laboratories: Professor F. W. Sperr, Michigan College of Mines, Houghton, Mich.

Materials Testing and Hydraulic Laboratories: Professor F. P. McKibben, Lehigh University, South Bethlehem, Pa.

Mechanical Laboratories: Professor A. M. Greene, Jr., Rensselaer Polytechnic Institute, Troy, N. Y.

Electrical Laboratories: Professor J. O. Phelon, Worcester Polytechnic Institute, Worcester, Mass.

The Engineering Laboratories of the Royal Technical University at Charlottenburg, Germany.

BY ROYAL R. HEUTER,

Instructor in Mechanical Engineering at Massachusetts Institute of Technology, Boston, Mass.

Up to the time of the World's Fair Exposition at Chicago in 1893, there existed at none of the German engineering schools anything for the purposes of instruction worthy of the name of an engineering laboratory. In a few cases, it is true, a modest equipment had been installed which enabled the professors to carry out before the eyes of the students a limited number of experiments, principally on heat engines. The opportunity for a close inspection and investigation of American industrial and educational conditions in connection with a visit to the exposition above referred to was taken advantage of by a large number of German professional men.

What they saw at our technical institutions in the way of laboratories brought home to their keen minds the great practical and scientific value of properly arranged and organized laboratories for the instruction of engineering students and for purposes of research and investigation.

To the energy and determination of these men, combined with a remarkable coöperation of the industries and the state, is due the inception and completion of a system of laboratory equipment and instruction in the engineering universities after the American prototype.

It is the intention in presenting this paper to discuss the main features of such an equipment at one of these schools in its present scope, and to show as completely as is possible in the brief time available in what manner and with what modifications, if any, the Germans have applied the ideas obtained from their co-laborers in the educational field on this side of the Atlantic. The case taken for consideration is that of the Technical High School, or Technical University, at Charlottenburg, near Berlin, Germany, which it was the privilege of the writer to have attended recently as a student in the Department of Mechanical Engineering, and with the main features of which he has therefore some reasonable familiarity.

To understand the reason for the extent and scope of the institutes connected with the school as a whole it is important to bear in mind, *first,* that in Germany the higher institutions are without exception government institutions, and that consequently as such one of their functions is to serve the state by providing technical education for those entering such branches of the civil service as of necessity demand technical training on the part of such individuals; *second,* that as state institutions all their departments and institutes are planned not only as educational factors but as possible factors in the development of the industries of the nation. We find therefore in every case that in the laboratories ample provision has been made for the performance of research and investigational work. Furthermore, it is the fixed and definite prin-

ciple of the government to grant to the men who give instruction in the institutions of learning every opportunity to develop themselves in their professions and to contribute materially through their efforts to the present knowledge in their various fields of activity.

As a result of these conditions we find at Berlin a splendid equipment, of which the following, under the control of the Department of Mechanical Engineering alone, is a good example of the whole:

1. The Electrical Laboratory.
2. The Mechanical Engineering Laboratory.
3. The Laboratory of Mechanical Technology.
4. The Laboratory of Strength of Materials.
5. The Experiment Station for Hydraulic Motors.
6. The Electrical Engineering Experiment Station.
7. The Laboratory for Combustion Motors and Motor Vehicles.
8. The Experiment Station for Elements of Machine Design.
9. The Experiment Station for Machine Tools.

Lastly, though not under the direct control of the Department but giving instruction to its students:

10. The Government Station for the Testing of Materials.

In many of these, instruction is given to the students; others are solely for the use of the instructing staff or are being developed by that body with the intention of ultimately providing for instruction or research on the part of the students enrolled in the various correlated courses.

Coöperation in University Laboratory Work.

BY R. L. STEVENSON,

Instructor in Electrical Engineering, Cornell University, Ithaca, N. Y.

It is the object of university laboratory work, especially in engineering, to correlate theory and practice. Now in the majority of these courses there are a certain number of set experiments, which of necessity follow a given routine each year, it being the usual custom to pay especial attention to the fundamentals in the junior year and to take up the practical application with more care in the senior terms. According to the law of progress, there is always an opportunity for improvement, and in no teaching work is this more apparent than in electrical engineering, to the end of keeping the applications in conformity with the best practice.

In a number of schools the regular course is supplemented with short thesis work, the large part of the subjects treated being of a somewhat more specialized nature than can well be incorporated in the normal curriculum. The greater the variety in this work, the more interest the student will show, and the better the results he will obtain. The suggestion has been made, that it would be possible to enlist the interest of the leading technical schools of the country in an exchange of items of interest pertaining to this laboratory thesis work, this exchange to take place systematically. This might be handled in either of two ways, with a comparatively small expenditure of energy and much benefit derived.

In our own laboratory here at Cornell a number of interesting subjects are being taken up this year. Among some of the problems of importance are "A Study of the Induction Generator." An induction motor is being used as a generator driven above synchronous speed, excitation being furnished by a synchronous machine. If time permits condenser excitation will be tried and comparisons made. Five of the seniors are doing this work. Another section is running some tests

on a variable speed repulsion induction motor, operating it with various connections. It is hoped that in the near future an induction motor of the Hobart type may be available for thesis test. This machine represents a new development in this field, being so designed that the secondary resistance is a maximum on starting, and as the motor speeds up this resistance is cut out, thus operating at normal speed as an ordinary motor of the squirrel cage type.

The first method for carrying on this interchange of ideas, and possibly the surest, would be to have some central point of distribution, to which each of the schools might send the suggestions and there be compiled into a general circular. The other method would be to have each college publish its own letter and establish a certain date for the exchange. This reduces, then, to a question of one general letter or a number of more restricted nature. As to the nature of these letters, that may be left an open point except in a general way. Any helpful suggestions pertaining to the various laboratory courses or their conduct, or references to special methods in particular experiments would be worth while. A description of the thesis work and list of the subjects treated would be helpful.

Therefore, I suggest that a committee be appointed to draw up a tentative plan of action for the carrying on of this work and that this committee be empowered to put the method selected in operation. I would also suggest that this be done for the coming school year in order to see how it works out.

The Engineering Experiment Station as a Factor in Education.

BY W. F. M. GOSS,

Dean of the College of Engineering and Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

A statement concerning the plan of organization and the work of the Engineering Experiment Station of the Univer-

sity of Illinois; the relation of the Station to the instructional work of the College of Engineering; the value of this work, both because of its stimulating influence upon the students and professors of the College, and as a factor in general education; and a discussion of some of the individual problems suggested by the operation of the Station.

Suggestions for Materials Laboratory Instruction.

BY F. M. McCULLOUGH,

Assistant Professor of Mechanics of Materials, Carnegie Institute of Technology, Pittsburgh, Pa.

1. It is desirable that class-room work in a good text-book on materials should precede the laboratory exercises by at least a few weeks and, under these conditions, I do not think it necessary to require students to read references on a test before performing it. The class-room work should accompany the laboratory exercises throughout the course.

2. The students should be provided with a laboratory manual or a set of instruction sheets which explains fully the methods of conducting the various tests, these instructions not to include blank forms for recording data. For a few standard tests, *e. g.*, the commercial tests of cement, steel and brick, printed forms may be distributed in order to economize the time of the student.

3. Assuming only one instructor in the laboratory and sufficient equipment, the number of students in one section should not exceed 12 or 15, the students to work in squads of three in performing the ordinary experiments. With this number of students the instructor can carefully supervise the methods of conducting the test and point out the characteristic properties of the materials, his work being made much easier if the students have previously had the corresponding class work.

4. In order to secure a report satisfactory in regard to English, accuracy of computation, descriptive matter and neat-

ness, the students as a rule should be allowed as much time for writing the report as is required for performing the experiment. It is not desirable that the students should write the reports before leaving the laboratory, but whenever the nature of the experiments permits, all computations should be completed as the test proceeds. All reports should be handed in within two weeks after the experiment is completed.

5. If students are required to spend three hours each week in performing the tests, no part of this time being reserved for writing reports, then more credit than one "term hour" should be given.

6. Our practise is to make no special charge against the students for cost of operation and maintenance of the materials laboratory but to include this fee in the tuition. Any breakage, however, is charged to the students who are directly responsible.

7. It is the policy here to encourage outsiders in this district and the laboratory instructors to make use of the laboratory equipment, a reasonable fee being charged for the service.

Coal Washing Laboratories.

BY C. M. YOUNG,

Associate Professor of Mining Engineering, University of Kansas, Lawrence, Kan.

Coal washing is a comparatively recent development of concentration. Neither the processes nor the results are yet well standardized. Few men have been trained for the work. It therefore offers an especially good field for the training of men and the investigation and development of apparatus and processes.

There are three purposes which may be served by laboratories at educational institutions: instruction of students, investigation of processes, and testing of different coals.

The equipment desirable depends upon the purpose of the

laboratory. A laboratory intended for instruction only requires less equipment than one intended for either of the other purposes. It should be possible to illustrate at least the more prominent processes and to give training in the handling of different forms of apparatus, but it is not necessary to have apparatus suited for the treatment of a large number of different coals. The apparatus may be on a small scale.

For research, the laboratory should have great flexibility, but does not need large apparatus unless investigations of capacities and costs are desired. All apparatus should have great range of adjustment. There should be opportunity for the development and installation of new apparatus and processes.

For testing large numbers of coals, the laboratory should be very flexible and of considerable size. Each coal presents its own problems and a process suitable for one may fail when applied to another. It is desirable that coals be treated on a large scale to determine the size of washery needed for commercial work. There should be considerable storage room and facilities for disposal of washed coal and refuse.

The article, as prepared for the Society, will include some description of the laboratory equipment of the University of Kansas, and a discussion of the kind and arrangement of apparatus which the author believes desirable.

Suggestions Regarding Laboratory Course in Hydraulics.

BY W. H. KENERSON,

Associate Professor of Mechanical Engineering, Brown University.

The author feels that an elaborate and expensive equipment in the hydraulic laboratory devoted to undergraduate instruction is not only unnecessary but may be undesirable. He describes an inexpensive equipment which is used to teach fundamental principles and their application to practice. Some of the methods employed and results obtained are described.

Testing of Engineering Materials

BY G. SAXTON THOMPSON,
Assistant in Department of Mechanics, Rensselaer Polytechnic Institute.

The object of any testing-materials course should be for the purpose of producing men better able to write specifications or to judge the value of any test which has been made according to some given specification.

Having determined upon the object, the "fixed policy" throughout the course should be such as to bring before the student the following points:

1. The importance of the test.
2. Standard specifications.
3. The apparatus and machines used for the test.
4. The method of making the test.
5. The data taken during the test.
6. The computations made to complete the test.
7. The accuracy of the results.

With a given "fixed policy" what are the various factors influencing the methods used in conducting a course in testing of engineering materials? Some of the various factors may be put down as: Equipment, types of machines used and their arrangement; the time required to make each test and also the time allotted by the curriculum. The number of students to be taken care of at one period and the size of each section has an important influence; and is specially so at Rensselaer because of the method of having one instructor in charge of each section, at each period every afternoon for six consecutive weeks.

Another important point to be considered in both outlining and conducting a course is the question of what tests should be made. Should mechanical, electrical and civil engineering students have the same course? The test for paving brick and other road materials should be given to the last named, also all cement tests. While there may be no question as to the testing of road materials how about the cement tests?

Granting that local conditions determine to a great degree the methods pursued at any institution, there are however many questions as to methods, results and equipment which afford material for discussion of value to all.

The following are some of the questions discussed in the paper of which this is an abstract:

1. Should printed forms be given students or should each student make up his own form of notes?
2. Should students be required to look up references and report on the tests in the light of these references?
3. What are the duties of the instructors?
4. Is a text-book advisable? If so what should be the contents and general arrangement of such a book?
5. Should examinations be given? If so in what manner?

Instructive Features and Efficiency of Laboratory Courses, for Undergraduate Students.

BY J. HAMMOND SMITH,

Professor of Civil Engineering, University of Pittsburgh.

In estimating the value of an engineering laboratory course, many features may be mentioned. Probably one of the most important is the fact that it brings the student into direct contact with the materials of the physical base on which the science of constructive engineering rests. An engineer should be well acquainted with the materials which are ordinarily used in engineering construction; and to get this acquaintance, he must come into direct contact with the materials. He must have the opportunity of working with them in various processes, such as cutting, bending, forging, welding, etc. He should test and observe them when stressed in tension, compression, shear, etc. He should learn of the relations of the various materials, by observation and experiment: such as the relations of cement, sand, gravel and steel, in reinforced concrete.

By laboratory work, a student may be benefitted in many ways—

1. His initiative and powers of perseverance are taxed, and thereby stimulated and developed. In other words, he is called upon to think independently and in a measure continuously, as will be required of him in his later professional life, if he is to be a successful engineer.

2. He must use his eyes in a discriminating manner, if the experiment is complete and serves its purpose fully. The matter of observing closely and thoroughly, and properly correlating the various features of an experiment must always be uppermost in the mind of the experimenter. Therefore the power of observation is cultivated and strengthened.

3. By his experiments the student becomes acquainted with certain properties of materials. He begins to know them by observation, which within limits, is the most definite and convincing method of learning. We all know that learning by listening to lectures or copying notes is frequently very ineffective until interest is first created by a practical demonstration of the subject under discussion. This seems to be especially true in the case of engineering laboratory work and other subjects related thereto.

4. The analyzing of experiments and writing of reports is undoubtedly of great benefit to the student: providing he receives no undue help from his classmates or other sources. The student should be required to study the results of his experiments, and should be encouraged to theorize upon them. He should constantly bear in mind that his reports should be methodical, neat, clear and concise. Care and experience are essential in attaining these qualities in technical writing. Therefore the careful writing of good reports should be an excellent method of greatly improving a student's powers of expression. By this he will learn how to cast and place sentences, to explain clearly the complex features of an experiment.

The author believes that the efficiency of laboratory courses could be greatly improved by requiring the student, after making the experiment, to analyze it and then prepare a complete report upon it as usual, after which he would be required

to give a recitation supplemented by blackboard work or other elucidation. This should be required for each experiment, or such as may be designated by the instructor. These recitations should be special, or supplemental, to the class-room work, which is generally of a theoretical or preparatory nature. The author suggests one hour of recitation to four hours of laboratory work as a good proportion. The character of recitation could be varied in many ways. The following is suggested as a general outline. The student would be expected to present a methodical, and more or less detailed discussion of the experiment before the whole class or section of students. After which questions and a general discussion would be in order. Methodical procedure, that is methodical thinking, in the analysis of the experiment, and presentation of discussions should be kept clearly before the class, in order that they may be trained to think in the most effective manner.

The main object of the recitation feature of the laboratory course would be; to get more out of it, to make the course more efficient in training for the young man. Or in other words, make it so that it would mean much more to him than simply "seeing the specimen break, or the water running." It is undoubtedly true that many students gain very little from laboratory courses, because in many cases it is possible to reduce the experiment and preparation of report to a routine method, thereby requiring little thought on the part of the student.

The good student, the thinker, the close observer with the analytical mind, will derive benefit from almost any laboratory course. But for the student who has not developed his powers of observing and analyzing there is difficulty in grasping the purpose and meaning of the problem, even if he be bright and a willing worker. Such students will improve as they get experience, but the author is of the opinion that for them recitations in laboratory work would be of great benefit.

The student should be prepared for laboratory work by having a good course in mechanics of materials, including the strength of materials, with all of their prerequisites. He

should have a good course in shop work, since the success of an experiment depends very largely on the proper adjustment and manipulation of the machines and apparatus, as well as the careful preparation of specimens for testing.

In laboratory work, the entire absence of preliminary oral or written instructions would, in many cases, be unwise. Only in those cases where the student is mature, and has had a great deal of laboratory experience, should this method be followed. Of course it will train and strengthen a student to throw him upon his own resources, but he should not be so completely left to himself that there is little chance of him making a beginning within a reasonable time. The better plan is to give him a brief printed outline containing the principal features of the experiment. This furnishes him with a few definite ideas, as to the object, character, method of experiment and requirements of report, which directs him to thinking and observing along the proper line and in the proper manner. The following is a sample of such an outline as used in the structural laboratory course, C. E. 10, at the University of Pittsburgh.

COURSE C. E. 10.

TESTS ON STRUCTURAL JOINTS, No. 3.

Angle tension member.

Object: To test a tension member, made up of an angle with connecting plates at the ends, for character of failure and ultimate strength. Also to compare the efficiency of angle to plate, connections.

Material: Will consist of angles $3'' \times 2'' \times \frac{1}{4}''$, and connecting plates $6'' \times \frac{1}{4}''$, the detailing to be worked out by the student.

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Apparatus: The punching will be done on the Riehle testing machine, the riveting on the Hanna riveter, and the testing of the member on the 200,000 lb. Olsen machine. The steel extensometer yokes, with dials, should be used in testing.

Method of experiment: The member should be carefully clamped in the pulling heads of the machine, with the steel yokes in place on the connecting plates, just outside of the ends of the angle. 2,000-lb. increments of load should be used, and simultaneous readings should be taken from beam and dials. The deformations, and character of failure of the member should be carefully noted.

Report: Should include a complete description of the experiment, with all data, curves showing relation between stress and change in length, and a full discussion of the results obtained.

This outline, with a small sketch showing the character of the member, contains all preliminary information. Instruction during the period of experiment is only sufficient to prevent serious mistakes. The students are allowed as much liberty in conducting the experiment as may be compatible with good results.

This experiment which includes the making, as well as the testing of the member, is usually assigned to groups of four or five students, and is a part of the course in civil engineering, senior year.

The author believes that best results may be obtained by preparation of reports outside of the laboratory. Nearly all reports require sketches and the plotting of curves, which can be better and more conveniently done in the drafting room. Tables and books of reference are needed in compiling reports, and these are not convenient in a mechanical laboratory. To get the most out of an experiment, each feature should be carefully studied. As a rule there is a great deal of noise and movement in a testing laboratory, which is not eminently conducive to effective study. A properly fitted adjoining room in which to prepare reports, would undoubtedly be an improvement over the practice of writing them in the laboratory.

Mechanical Laboratory Reports.

BY H. E. EHLERS,

Professor of Experimental Engineering, University of Pennsylvania.

Relation of reports to laboratory work in general.

Value of reports to the student—in the course, and in after life.

Character of reports—various kinds, reasons for each and relative value.

Manner of presentation—use of forms and general physical "get up"; arrangement of technical material.

Time required—a fair allowance; some actual figures based on a year's time study; an attempt to reduce the time required without sacrificing the quality of the work.

Criticising and checking of reports by the teaching staff.

SYMPOSIUM ON SCIENTIFIC MANAGEMENT.

Abstracts of papers to be presented at the twentieth annual meeting of the Society, to be held at Boston, Mass., June 26, 27 and 28, 1912. Discussion is invited. Communications may be addressed to Mr. Frank B. Gilbreth, 60 Broadway, New York City, or to the Secretary.

Academic Efficiency.

BY WILLIAM KENT,

Consulting Engineer, Montclair, N. J.

By an account of two experiences in improving efficiency, in a factory and a college respectively, the paper shows that the problem of the college is in many respects similar to that of the factory, but the factory has an advantage over the college in that competition may force the factory to improve its methods while the college has no such stimulus. Several definitions of efficiency are given, and that of Harrington Emerson is commended—"the relation between an equitable standard and an actual achievement," or "the relation between what is and what could be."

Are the results of our educational systems what they ought to be, in kind, in quality, or in quantity, and if they are not, what are the defects and how can they be remedied?

The investigation by Morris Llewellyn Cooke, for the Carnegie Foundation for the Advancement of Teaching, of the "cost of a student-hour" in the teaching of physics showed that the great differences in this respect exist in different colleges. The investigation of the efficiency of the student-hour, that is what return in valuable education the student gets for the expenditure of the thousands of student-hours that he spends in college, will be a far larger task. If such

an investigation were made in a dozen or more institutions of learning, no doubt the result will be startling.

Mr. Taylor's system of management of factories cannot be adopted without many modifications by an educational institution, but his system of experimentation can be. It is simply the careful collection of all the facts by an expert, their study by mathematical methods, the making of experiments to get more facts, their further study, and careful reasoning to arrive at correct conclusions. It takes years of time, thousands of dollars of money, and can only be undertaken with any probability of reaching valuable results by a scientific expert who is unhampered by old traditions. The motto of the conservative is "Whatever is, is right," that of the scientific expert is "Whatever is, is apt to be wrong; I am going to test it and find out whether it is right or wrong." The paper concludes with an outline of an educational investigation and experiment for the purpose of improving the efficiency of educational methods, and arriving at standards of measurement of efficiency. As planned, the experiment will last nine years and cost half a million of dollars.

Departmental Organization and Efficiency.

BY HUGO DIEMER,

Professor of Industrial Engineering, State College, Pa.

During the past three years in conducting the department of industrial engineering at the Pennsylvania State College, we have held regular weekly meetings of the department. At these meetings there has been the freest discussion of questions of policy and organization, as well as questions dealing with methods. The results have been extremely gratifying. There is no question in the minds of any of the members of the department but that the meetings have resulted in cooperation, enthusiasm and accomplishment of results, which under old methods of organization, would seem impossible. Among the matters which have been taken up by the department are the following:

Consideration of courses and establishment of new courses including: (*a*) courses leading to a degree, (*b*) topical courses.

Two new courses leading to a degree have been established; namely, the four years' course in industrial engineering and the four years' course for teachers of manual training.

New topical courses have been introduced as follows: furniture design and construction, painting, pipe-fitting, plumbing, sheet-metal work, time and motion study, lecture and recitation courses in machine-shop methods, in foundry and pattern shop methods, in factory accounting, factory economics and factory planning.

A canvass has been made by the department of schools in Pennsylvania teaching industrial training, manual training, vocational training and the trades; ascertaining their methods and facilities.

The department is establishing a laboratory and museum of industrial education.

A committee of standards of the department determined the duties, responsibilities, authority, routine and teaching schedule of each member of the department, and has put same into writing and also in the form of a graphical chart.

The department has initiated coöperative extension work with the local school system.

We have introduced planning systems and detailed instruction cards into all of our shops.

We have established an apprenticeship system.

We have developed our construction shops on a commercial and self-sustaining basis.

Among other matters taken up by the department and carried through to a successful finish are the following:

Establishment of departmental accounts on a double entry system.

Reviewing of recently published books bearing on subjects taught by the department.

Deciding on books to be purchased and magazines to be subscribed for.

Distribution of expenses and allotment of fees.

Arrangement of equipment, of offices, files, desks, etc.

Alterations in lighting and power transmission systems.

Records of grades, absences and departmental regulations, as to excuses for same and how they are to be made up.

Continuous inventory of stores, and equipment, together with proper depreciation charges.

First aid to the injured.

Methods of teaching manual work, including: comparison of French, German, Russian and Swedish methods as well as methods in vogue in various American schools.

Kinds of shop work acceptable for entrance requirements.

Schedules of instructors; subjects and rooms.

Use of equipment by students outside of class time.

Lectures by visitors.

Maintenance and repairs to equipment.

Summer school courses for teachers to be offered by the department.

Standardizing, filing and indexing of drawings, catalogs and other memoranda for reference.

THE TEACHING OF SCIENTIFIC MANAGEMENT IN ENGINEERING SCHOOLS.

BY HOLLIS GODFREY,

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Courses in scientific management should be based on the fact that the industrial engineer must use the powers of observation and of analysis as they are required by the specialist in research, of synthesis or of construction on the basis of the analysis, and of expression or the intelligible rendering of the results of analysis or of synthesis. To put it otherwise, the worker in scientific management must possess the power of using the best work done before for the solution of his problems, the power of making effective research into unknown fields and the power of making the results of his studies and researches intelligible and useful to men. These powers by no means go together.

The preparatory technical work of the student may be done in any of the regular engineering courses provided that those courses are strong in English, mathematics and science. It is seldom difficult to find strong courses in mathematics and science but English, an equal essential to the industrial engineer, sometimes receives less than its due from engineering schools. The worker in scientific management must make his results intelligible to the workman in both written and verbal form and his training in English must be thorough.

The specific courses in scientific management in an engineering school should not begin until the junior year. Together with his other academic and technical subjects the student who elects scientific management should be required to take, during his junior year, a year's course in economics, a year's course in physiology, hygiene and sanitation and a year's course in scientific management. These three courses should be closely correlated, as should be the courses in English, mathematics and scientific management.

In the senior year the student in scientific management should be required to take an advanced course in economics during the first half year. During the second half year he should take a course in the theory and practice of accounting. He should be required to take a full year's course in psychology including experimental psychology, and a second year's course in scientific management. The courses in the senior year like those in the junior should be closely correlated.

The courses in scientific management may be readily divided into four half courses which for convenience sake we may call Scientific Management IA and IB, IIA and IIB. These courses should require at least three hours lecture and recitation time and three hours of laboratory work. The laboratory work should be done in allied industrial plants or in the shops of the engineering school.

Scientific Management IA should consider the movement of work through all the departments of a business in at least four distinct plants representing four different industries.

It should give broadly the principles of the science of management now developed. It should separate the factors which are common to all industries from those which are individual to one industry and show that it is the business of the industrial engineer to bring the best of all known science to the aid of an industry, and to bring the best of scientific methods to the solution of all unknown industrial problems. Studies of statistical methods of research should be included in this half course. At the end of the half year the student should be required to present a report showing his observation and analysis of all the operations of a single actual plant, preferably not one of those studied by the whole class.

Scientific Management IB should show the way in which mechanisms or systems can be developed from scientific studies and should consider a number of mechanisms already in practical use in the design and planning of work. This course will, therefore, take up the problems of stores, of design, of routing, of tools, of order of work, etc. It should also take up problems of industrial hygiene and sanitation in correlation with the course in physiology, hygiene and sanitation. At the end of the year the student should be required to present a report showing an actual constructive piece of work done by himself which solves successfully a real industrial difficulty.

Scientific Management IIA should take up the actual study of shop work and of time and motion study with especial reference to the elimination of all disagreeable and dangerous elements from industrial operations. (This study *should be done* in the shops of the school.) Functionalization in the shop should be carefully considered here, as well as the problems of properly prepared instruction cards, and of proper methods of record. Here also should be taken up the great problem of the scientific development or education of the worker. The selection of the worker for his task should be considered near the end of this half course. At the end of the half year the student should present a report showing a detailed study of a given operation, the preparation of in-

structions for that operation and the method by which he would teach the workman to work in the proper way.

Scientific Management IIB should take up the study of sales curves, methods of inventory taking, problems of purchasing and the development of work in time and costs. The course in accounting should be especially correlated with the work in time and costs. At the end of the year the student should be required to present a report showing sales curves, purchasing curves and a detailed cost sheet for some single plant.

The Engineer as a Manager.*

BY H. L. GANTT,
New York City.

The industrial developments of the past fifty years have been so great as to modify profoundly, if not to revolutionize the methods of living in the whole civilized world. If we will compare the conditions and methods of living just previous to the Civil War with those to today, and itemize these differences, we shall find that they are due in a large measure to the development in the mechanic arts.

Fifty years ago the peaceful methods of accumulating wealth were substantially those that had been in vogue since the dawn of history, and consisted of buying, transporting and selling, with the lending of money to finance such undertakings. Ancient Persia, for instance, owed its great wealth largely to its position, by which it controlled all the trade routes between India and China on the one hand, and Europe and Africa on the other.

When, however, the Greeks extended their colonies along the shores of Asia Minor to the eastern end of the Black Sea, and finally even founded settlements at the eastern end of the Caspian Sea, the conditions began to change. Persia no longer had a monopoly of the trade between the east and the

* Paper, in full, to be presented at the Boston meeting.

west, for the Greeks had a nearly continuous water route by means of the rivers of southern Russia to their markets on the shores of the Mediterranean. The competition of a cheaper route soon awakened the Persians to their danger, which they tried to avert by the conquest of Greece. Failing in this they were themselves subdued by the Greeks, and the greatness of Persia passed away.

A continuous series of similar illustrations might be cited, bringing us down to the present time, where a situation similar to that between Persia and Greece has arisen between England and Germany.

The other time-honored method of accumulating wealth is that of Rob Roy: "They should take who have the power, and they should keep who can." This method is not only just as much in vogue today as when the tribes living in the mountains made excursions into the valleys and carried off the corn and cattle of their more thrifty neighbors, but it seems to be quite as respectable and to be carried on with far less personal risk.

In the past these two methods have as a rule been operated by different classes of people who were in the main hostile. In recent times, however, when the physical methods of Rob Roy have been suppressed, more subtle and effective ones have been developed, which apparently do not violate our time-honored laws, and which can be successfully operated in connection with legitimate trade.

Thus the already wealthy traders and bankers have been able to add to their methods those of the outlaw, and to become in the words of the great Senator Dolliver, whose untimely death was such a loss to the country, "the boldest set of buccaneers the world ever saw."

In the past the great traders individually exerted but small influence over the markets in which they bought and sold, and prices were governed by supply and demand. Today, however, in this country at least, the great trusts are in many cases able to fix both the buying and selling price of the commodities in which they deal. A dawning realization of

this fact was the reason for the enactment of the Sherman anti-trust law, and is now the strongest force behind the agitation for a decrease in the tariff.

Further the enormous wealth thus accumulated has enabled the possessors in many cases to become absolute owners of the sources of wealth and the means of transportation, and their training to get as much as possible and to give as little as possible in return is doing much to increase the present industrial unrest in the world.

While these developments have been taking place, others have been going on which up to this time have produced even greater results.

The invention of the steam engine, by furnishing cheap power, made possible the factory system of today; but it was nearly a century before the engine was sufficiently perfected and the mechanic arts sufficiently developed, to make the factory system very profitable on a large scale.

Although the advance of scientific knowledge was very marked during the latter part of the eighteenth century and the early part of the nineteenth, there was a strong feeling that knowledge for its own sake was the true ideal to be striven for, and to make any practical use of it was degrading. Such men, however, as Rankine and Isherwood rose above this prejudice, and although they showed the advantage of applying scientific methods to mechanical problems, and especially to the steam engine, it was not for some years that a large enough body of scientifically educated men was engaged in this work to make any substantial progress.

Soon after the close of the Civil War the need of such a body of men was recognized, and schools were founded with the express object of teaching men how to apply scientific knowledge to industrial problems. In a few years the graduates of these schools began to make their influence felt, and the scientific methods of the engineer began to supplement the empirical methods of the mechanic.

Labor-saving devices and automatic machinery began to be developed that often multiplied many times the power of

the individual to produce wealth, and almost all the machinery in use at that time has been improved and made more efficient. In the art of transportation, the steam locomotive has been enormously enlarged and perfected, while the electric motor has made possible the rapid transit of our cities with all that implies. The steamship of today has robbed ocean travel of its discomforts, and cut in half the time between Europe and America. The automobile enables us to travel at sixty miles per hour along country roads, and the aeroplane makes possible a like speed through the air.

The developments of electricity have been more marvellous still.

The telephone, the electric light, the wireless telegraph, the long distance transmission are familiar to us all, but we realize their importance only when we consider what would happen if they were all destroyed.

These facts which are so well known are typical of the developments that the engineer and the mechanic have been making in all shops and factories throughout the country, and producing the wealth that has so much increased the splendor of our great cities in the last few years.

True to his traditions of buying at the lowest price and selling at the highest, the commercial man has continued to apply these principles to all his dealings, including the purchase of labor. The combinations, or trusts, derive their strength and profit, not from their ability to produce more cheaply, as was at first claimed, but largely from their ability to fix both the buying and the selling price.

The workmen, on their part, recognize these facts, and realize that the only effort to get a greater reward for their work is one backed by force. Hence under these methods of doing business, the growth of trusts on one side, and hostile labor unions on the other, is a natural development. Further, the workmen, realizing that they get but a small share of the increase in wealth produced by greater efforts on their part, or by improved machinery, are not only slow in exerting greater efforts, or adopting improved machinery, but often

opposed to both. Thus, much of our industrial development is carried on under conditions where one party and often both are hostile to such developments, for the commercial man is also often opposed to improved methods. Such methods usually cost money to install, and he being interested only in profits, does not see any advantage in effecting economies if his competitor is able ultimately to do the same. Thus where the control of a plant is in the hands of a man of commercial instincts, or training, there is apt to be but little interest in effecting economies that cost money; and, as many of our plants are under such control, this condition is widespread.

Such a man too often does not appreciate differences between workmen, and groups them into classes of uniform pay, thus discouraging initiative in mechanical production, and driving it into union leadership. Under such management there does not seem to be any possible method of harmonizing the interests of employer and employee, and unless these methods are modified, the industrial unrest is bound to increase, with results which no one can foresee.

Until recently the engineer has regarded his work done, when he has developed an improved machine or apparatus, and proved by operating it for a short while that its capacity was all he claimed for it. It has then too often been acquired by men imperfectly trained mechanically, but who had the commercial instinct highly developed. Such men usually turn it over to a "cheap" man to operate, and its maintenance is nearly always looked after by a second-rate mechanic, for the commercial man can seldom see why he should have a high-priced man doing repairs.

The efficiency of the machine naturally decreases, and a factory run on these principles must necessarily be more inefficient still.

Fortunately this condition is not universal, for the advantage of having an engineer for a manager has for years been recognized by some, and the number of such is increasing. This number is not sufficiently great, nor has the engineer

yet had sufficient training in the art of management to make untrue the statement, which has been so loudly proclaimed recently, that the majority of our industries are very inefficiently managed.

In as much as most factories are controlled by men of commercial instincts or training, their gauge is necessarily not efficiency, of which they know nothing, but profits, of which they know a great deal.

If we would increase the efficiency of a plant, the problem must be put up to a man who knows at least what the word means. Fortunately the man who knows most about efficiency also knows most not only about the application of science to the mechanic arts, but also about workmen, by whose side he has obtained his knowledge and acquired his skill in the use of tools. This man is the engineer. *He is the only man who spans the whole gap between the capitalist and the workmen, and knows the mental attitude and necessities of each. It is on his shoulders therefore that must fall the burden of harmonizing their interests.*

As said before the engineer has too often been content when he has built his machine or plant, and his training has largely been confined to preparation for this work. Now, however, when the larger responsibility of management thrusts itself upon him, his education and training should include at once the elements of his new duties.

The greatest problem before us today is not that of developing new and better appliances, but that of properly utilizing those we have. The recognition of this fact has given rise to the tremendous interest in the subject of management which has become manifest in the last few years. Interest, however, is not enough. Knowledge must be obtained before great progress can be made.

The subject of management may be divided into three groups, management of men, management of machines, management of materials. The one which the engineer has given the most study to in the past has been the management of machines. How to care for materials and to move them

through the factory as they are wanted, so that there may be no delay, has been given but little attention. This has often been left more or less to chance, and it is very seldom that we can find a proper system of storekeeping and routing material. We almost never find that material moves along its route according to a prearranged schedule. Such a schedule, however, is necessary in order to keep the workmen properly employed, and we have found that proper routing and scheduling of material has not only done much to promote harmony and efficiency in every shop in which it has been installed, but has prepared the way for a satisfactory method of managing men.

The men are thus largely relieved of the innumerable annoyances with which they are troubled in shops without a proper system of management, and where everything is done on the spur of the moment by the direct order of a foreman.

In studying how to use workmen efficiently, we must recognize the fact that they are just as susceptible to petty annoyances as their superiors, and that as a rule they are just as anxious to take advantage of any opportunities that are offered them, if they are benefitted by so doing. No sooner do we, as a rule, afford opportunities for men to show their ability and to advance themselves, than some begin to come to the front. We must not, however, expect by any system of management to produce a revolution. If we can put in a system by which the workman is benefitted and enabled to utilize his powers to the best advantage, although he will gradually recognize it, we must not expect him to do so at once, for his experience in the past has taught him that his employer has no interest in his advancement and will give him only such compensation as he is forced to give. Having lived under such a condition for years, which is necessarily one of antagonism for his employer, time must always elapse before he will believe that the opportunities apparently offered him are real.

If, however, the work is done under a properly trained

engineer, who recognizes the advantages of proper coöperation, and is willing to share them with the workmen, we have no difficulty in ultimately bringing him to a proper frame of mind.

Our difficulty has been mainly with the commercial man, who often seems incapable of considering anybody's interest except his own, and has not yet recognized that the prosperity of all is directly helped by the prosperity of each. As yet he has no idea of what real coöperation means. His idea of coöperation is that of the pack, or herd, whose coöperation is for attack or defense. Geo. W. Perkins and Samuel Gompers are the most prominent public advocates of this kind of coöperation, which aims to spoil the outsiders for the benefit of those in the ring.

For that broader idea of coöperation which benefits the country and people in general, I refer you to the address of Hon. William C. Redfield, before the National Democratic Club of New York City on January 3, 1912, printed as a part of the Congressional record. Mr. Redfield recognizes the fact that the civilization of today is an industrial civilization, and that the nation that first realizes this fact, and acts upon it intelligently will put itself far in advance of all the others.

In as much as it must not be expected that the commercial man will thoroughly understand this for many years, it is all the more incumbent upon the engineer to assume the responsibility for showing what true coöperation between employer and employee means.

The great development of what is popularly known as "efficiency engineering," but what might more properly be called "management engineering," is a recognition of the readiness of men having even a little engineering knowledge to assume the new responsibilities. The fact that the movement is still growing, although many now engaged in it must necessarily be incompetent, is evidence that some good is being done. How much faster it will grow, when all engaged in it have had a proper preparation for their work! This preparation it is the duty of the engineering schools to give.

In as much, however, as the peaceful solution of our industrial problems will bring far greater financial gain to the commercial man than to the engineer, it would seem to be to his interest to finance liberally such engineering schools as will undertake this work.

In the past, merchants and financiers, like nations, have been ever ready to spend money to fight their opponents, even when they realized what enormous losses these fights involved. Now, however, when the way of avoiding such fights becomes clear, it would seem logical for them to invest a small fraction of the money needed for fighting in the only rational scheme that presents itself for the insurance of industrial peace and coöperation.

SYMPOSIUM ON EFFICIENCY IN TEACHING.

Abstracts of papers to be presented at the twentieth annual meeting of the Society to be held at Boston, Mass., June 26, 27 and 28, 1912. Discussion is invited. Communications may be addressed to Dean G. C. Anthony, Tufts College, Tufts College, Mass., or to the Secretary.

Efficiency of Technical Education.

BY GEORGE H. SHEPARD,

Formerly Dean of the College of Applied Science, Syracuse University, now associated with Harrington Emerson.

The paper applies Emerson's Twelve Principles of Efficiency in an examination of the efficiency of technical education, with the following general conclusions:

Ideals.—Instruction and research are in conflict and should be reconciled and carried on harmoniously. Ideal of purpose and scope of undergraduate courses lacks clear definition.

Supernal Common Sense.—The sciences of psychology and pedagogics on which the art of teaching is based are ignored, or applied only crudely and empirically.

Competent Guidance.—Staff organization is lacking.

Discipline.—Is very good.

Fair Deal.—Is almost perfect.

Standardization of Conditions.—Principal lack is close contact of students with industry.

Determination of Standards.—Standards of student capacity, except arbitrary ones established by guess, are lacking and should be determined.

Standardization of Operators.—It is most important that the student should solve his own problems, less important that he should solve them in the best way. Hence this principle has a somewhat limited application to educational work.

Standard Practice Instructions.—Should be provided as to many details of work in order to save time and labor.

Planning and Despatching.—Are generally better than in industry, but lack a basis of scientifically determined standards. These should be determined and present general schedules should be supplemented by schedules for individuals.

Records.—Are reliable and adequate, but not immediate.

Efficiency Reward.—Students should be made conscious that knowledge is their reward. Teachers should be better and more consistently rewarded than they now are.

Staff Supervision in a Technical School.

BY W. F. M. GOSS,

Dean of the College of Engineering and Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

The traditional objection in university circles to any system of close supervision of an instructor's work is referred to and commented upon. The peculiar needs of the technical schools are emphasized. An organization maintained for the purpose of training men to execute effectively, must itself be organized for high efficiency. Effective supervision is only possible through the medium of a well arranged organization. Supervision is not primarily for the purpose of repressing and restraining those members of the staff who are inexperienced or who for any reason may not be entirely trustworthy, but it is chiefly for the purpose of inspiring action and shaping the trend of effort. Few men are so strong that they can be depended upon to do their best without leadership. The purpose of supervision should be to supply, through the exercise of many different influences, this necessary element of leadership.

The Engineering Seminar Class.

V. L. HOLLISTER,
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The writer has observed that a class, which in some schools is called "The Engineering Seminar," in other schools "Class in Technical Reports," is generally regarded by students in one or three ways—it is either a pleasure, an "easy snap," or a bore, depending upon the material presented and the amount of enthusiasm aroused by the manner of its presentation. Descriptions of engineering works with lengthy details and tables of figures, while theoretically valuable to the student and class, are generally to be avoided. The assignment of technical papers to be reviewed by a member of the class seems to be of value only in so far as the student's interest is aroused and he brings up items of real interest to the class. Past experience has led the writer to believe that few students having been assigned a single number of the magazines for review have sufficient enthusiasm over a particular article, or such other item as may be contained, to present its contents in an inspiring manner. On the other hand, if a student is assigned to read and report on articles carefully selected, it would seem that the instructor were simply assigning tasks and not developing the initiative of the student. Some little consideration seems to indicate the following general principles as covering in general the advisability of having a class in engineering seminar.

The student should be induced to seek the acquaintance of the contemporary technical press.

The class should afford a place for the student to present and discuss technical subjects before his equals.

To some extent, the discussions should perform the services for the engineering students equivalent to that afforded by the literary classes and debating societies held for the students in other colleges; he should learn to talk and argue while standing upon his feet.

The class should afford a place where the broader elements of engineering, such as a choice of systems, the economics of wage payment, or engineering methods are properly discussed.

The preparations for the class should require the students to search and to learn how to find the information contained in the technical press at hand. In other words, to acquaint him with the resources of the library.

The class affords the instructor an opportunity to equip the student with information other than purely theoretical and the technical details covered in other courses.

In conducting such a course, it has been the practice of the writer to lay down four principles, covering the work, to be kept in mind.

First, to learn how to search the technical press for information and become familiar with the general classes of materials handled by particular magazines.

Second, to present subject matter while standing before the class in a clear, logical and forcible manner.

Third, to weight and take part in the discussions of subjects of interest to the engineering profession.

Fourth, to obtain some additional information.

Much depends upon the class of subjects assigned the students upon which they are to report, and it is here that the instructor will find his greatest energies needed. The following list of subjects is suggested as having been tried and found successful.

Review and Comparison of the Growth and Advance in the Electrical Field during 1911 as Compared with 1905.

Comparison of the European Practice in Electrical Engineering with American Practice.

Alternating Current Traction.

Direct Current Traction.

Contracting Methods—Compensation by Fixed Sum, Percentage and Other Plans.

Shop Organization.

Compensation and Efficiency of Workmen, *Ref. Eng. Mag.*, March, 1910, pp. 813.

Works Management—Am. Soc. Mech. Engrs., May, 1906.

The Appraisal and Depreciation of Water Works and Similar Properties. *Jour. Assn. of Engrs. Soc.*, Dec., 1907.

Useful, Uniform Accounts and Reports of Water Supply Systems. I. G. Powers in *Am. Water Wks. Assn.*, June, 1909.

Electric Ship Propulsion.

Western Union Time Clock System.

Aluminum and Its Manufacture.

Steam R. R. Electric Train Lighting Systems.

Review of *Pro. Inst. of Elec. Engrs.* and *Pro. A. I. E. E.*, 1910–1911. Comparison and Notes.

Rates for Public Service Corporations, *Eng.-Con.*, May 25, 1910, pp. 467.

Government Ownership of Public Service Corporations.

Employers' Liability Laws.

Hydro-electric Engineering.

Electric Railway Signal Systems.

The Electrolytic Industries.

Insulations and Their Applications.

Public Service Control Commissions.

The Engineering School Graduate. *Eng. News*, April 20, 1911.

Apprenticeship Courses and Continuation Schools.

Piece Work. *Eng. Mag.*, May, 1911.

The Bonus System of Efficiency Reward.

Diversity Factor, Load Factor, and Plant Location as Affecting the Central Station.

The Storage Battery, Its Engineering Features and Applications.

Machine Telegraphy and the Telepost.

Having been assigned one of the above subjects, in some cases a specific reference is given, a student seeks such information as he may find either in the technical press or in standard books upon the subject. He then makes up a bibliography of the best references, and having prepared a few brief paragraphs showing the scope of the articles upon which he desires to draw for his class presentation, the written outline is submitted to the instructor a few days previous to the weekly meeting of the class. The written work that seems to mean the least amount of effort for the greatest returns is best illustrated by the following brief outline on the "Bonus System of Efficiency Reward," as presented in my class on a recent date.

"BONUS SYSTEM OF EFFICIENCY REWARD."

MR. JAMES K. HEWETT.

References.

Twelfth Principle of Efficiency. *Eng. Mag.*, July, 1911—Harrington Emerson.

Article Substantiating Same. *Eng. Mag.* July, 1911—Alonzo Flock.

Eng. Mag., Apr., 1911. Article by H. L. Ganett, "Practical Application of Scientific Management."

American Eng. & R. R. Jour., June, 1907, Oct., 1907.

"Basic Cause of Increased Efficiency." *Eng. Magazine*, Dec., 1908.

Eng. & Contracting, March 17, 1909.

Eng. Mag., Feb., 1910, and Apr., 1910.

The Minnesota Engineer, Mar., 1911.

"Aspects of the Premium and Bonus Systems." Stenley G. Harwood.

Outline.

[Brief paragraphs showing scope of articles as listed.]

The premium and bonus systems, as their names imply, are methods of paying for labor in which a reward is offered for efficiency, and differ only in the method of accomplishing the end. Harrington Emerson says that an efficiency reward is the only system which can be called correct, and by which men receive their just compensation.

. . . . . .

In the early history of our country a man began as an apprentice and rose to a journeyman, boss, and later owner. This rise was all through individual effort, and under the day wage system. Then a man had a chance to rise, to become manager of the firm and owner, while now where industry is on a larger scale it is not possible.

The day wage system is wrong. It is contrary to the underlying principles of efficiency reward, and all principles of equity.

. . . . . .

In order to administer the efficiency system, the man must be capable of doing the work himself for a thorough knowledge of the subject, and he must be a careful student of human nature.

The management of a plant gains by the elimination of unnecessary waste—increased efficiency—if there is a twenty per cent. increase in efficiency of the operating machines, which means a gradual output without increased investment, then there is a relative decrease in the overhead charges per unit manufactured.

Efficiency reward systems have shown the following favorable results as listed.

Shop No. 1.—Wages increased 14.5 per cent. to the man. Decrease of

unit cost of production 36.3 per cent. Increase of shop output 57 per cent.

The average man gets 25 per cent. more wages than previously. Total shop increase from 60 per cent. to 94.2 per cent.

The greatest advantage of efficiency reward system is that the employer and employee's interests are one and the same.

There is an element in the success of this class which does not appear until several meetings have been held. It is best described in the pedagogical term of "sustained interest." Subjects which do not provoke discussion, which have no disputable statements, which have little or no humor in their presentation, bring about a state of lethargy of the members of the class, at once defeating the aim of the course. An uninteresting presentation of a subject of even vital interest, or rambling remarks upon an unprepared subject, being the usual order of things, soon dooms the course to failure. A high order of discussion and subject presentation must be established, and it is this part of the work which rests upon the instructor. It is the writer's practice to read in a spirited manner some "gingery," inspiring articles before the class during the first three or four meetings held. Such magazine articles as are contained in Mr. Harrington Emerson's series of "The Twelfth Principles of Efficiency," published in the *Engineering Magazine* during 1908 to 1911, are at once inspiring and excellent for this purpose. When such topics as have received special attention at the hands of other members of the faculty are being considered by the class, it is well to call upon such men to listen to the paper read and take part in discussion.

Setting Tasks For College Men.

BY SANFORD E. THOMPSON,

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In nearly all colleges there are certain studies designated by students as "snap" courses. Where the elective system is in full force, it follows inevitably that a student can select

courses that will permit him to obtain a degree with a remarkably small amount of brain exercise during any one of the four years of residence.

At the Massachusetts Institute of Technology, the institution with which I am most familiar, and I presume also at other technical universities, "snap" courses are hard to find. For the attainment of a degree in science, a student must follow lines of study which are closely prescribed. Yet even in these schools, noted for their "grinds," there is a marked difference between the amount of work required by different departments and by different instructors in the same department. Furthermore, different lessons and exercises in the same course frequently vary to a great extent in the time required for preparation or performance.

Partly as a result of such variations, a common complaint of employers of college graduates and technical school graduates is on the ground of the inability of the latter to attack a job in a business-like manner and complete it in a reasonable time—their lack of "know-how-to-work." Frequently along with this is the failure to realize that a simple error in addition or subtraction may be even more serious from a commercial or engineering standpoint than an error in method of computation. In filling positions in my own organization where the applicant is a recent graduate, my first question is with reference to what practical work he has done before or during his college course; can he turn out a piece of work not only in the proper way, but quickly and accurately? We frequently hear the statement—true, however, only with a portion of the students—that a man is not good for anything until he has been out of college at least two years. For an engineer, a knowledge of mechanics is a fundamental requirement, but except where mathematical analysis is required, I prefer to instruct a man in method rather than in accuracy and speed. He will learn the former quicker than he will the latter.

The problem of developing more fully this power of accomplishment is no simple one, and I do not refer to the matter

in a spirit of criticism—I speak from the standpoint both of an employer and of a lecturer in two universities—but with a view to calling more definite attention to this point, with the object of suggesting a definite line which may be followed for inducing improvement.

The difficulty of estimating the task of a student in shop work by guess was called to my attention recently in a technical school which I was visiting with a class of graduate students from a neighboring university. The task given to the boys was the making up of wooden boxes, and the time to make up two boxes was estimated at 1½ hours. The boys knew they were being watched and, boy fashion, tried to make a record. One of them completed his first box in 12 minutes and his second in 11 minutes, about one-fourth the time scheduled. This boy worked too fast, at a speed greater than he could maintain throughout the day and produce good results. On the other hand, the estimated time was unquestionably too large. The proper time for the task lay somewhere between the two.

In the shops of one large institution in this vicinity—and I am told that it is one of the few in the country which go as far as this—the instructor has scheduled the time that it ought to take for each of the regular pieces of work to be done. While not given specific times for the tasks, the student is expected to accomplish a certain amount of work during the term. This is a step in the right direction. It would be still better for the instructor to have records based on unit times, which should be so accurate that the student could accomplish each job within a definite fixed time, a record of his actual performance being kept on file.

To see how some of the students actually worked, compared with the task that would be expected of a machinist working under scientific management, one of my assistant engineers made time studies of certain operations in the shops referred to. These times were then compared with the times that would be fixed in practice for such jobs for a man to do the work and receive a bonus. In one case the result was very good indeed,

the student's time being 43.2 minutes against a task time of 30.2 minutes. The ratio between these is no more than would be expected between an average man and a man working under task and bonus. In the other case the student occupied four times the task time. The times of the operations are given in the following table. The unit times are not given individually but are grouped together into definite operations for comparison.

In the operation of the task in practice, the man must turn out a product of a definite quality and in a definite time in order to receive his bonus. Why in such work as the shop and the laboratory, where the same pieces of work occur year after year, should not the tasks be set in advance, not simply according to the judgment of the instructor, not by records of past performance that may or may not be accurate, but by a really scientific analysis?

That this can be done is not merely theory, but it has been worked out to a limited extent in practice. In a certain school, tasks in the chemical laboratory were set by actual time study. Such work as this naturally lends itself to exact analy-

BORING A $\frac{3}{4}$" AND A $\frac{7}{64}$" HOLE COMPLETELY THROUGH AND A $\frac{5}{8}$" HOLE $\frac{3}{4}$" DEEP IN A PIECE OF CAST IRON 4" $\times 1\frac{7}{8}$" $\times$ 1" THICK.

Hill & Clarke High Speed Drilling Machines.

	Student's Time, Minutes.	Task Time, Minutes.
Drilling 3 holes	6.47*	1.44
Clamping and handling piece	12.76†	1.03
Setting drills and drawing center	13.55	3.30
Changing drills	1.70	1.13
Reaming	4.97	4.00
Cleaning up and lost time	5.12	...
Total time	44.57	10.90‡

* Includes 2.14 minutes calipering hole.

† The bed of student's drilling machine was not adjustable for these times, while the task times are given for an adjustable bed. This accounts for a considerable part of the difference in this item.

‡ Includes allowance for lost time and delays.

MAKING LIVE CENTER FOR 12" REED ENGINE LATHE FROM 6" × 1 1/16" DIAMETER PIECE OF MACHINERY STEEL.

Reed 12" Engine Lathe with High Speed Tool Steel.

	Student's Time, Minutes.	Task Time, Minutes.
Preliminary work (getting correct taper) etc.	7.56	5.00
Rough turn, main portion	5.00	3.70
Finish cuts, main portion	3.02*	4.62†
Turn small end	2.10	0.50
File and fit	7.45	3.50
Rough turn joint	4.25	1.65
Trim joint	3.62	2.50
Adjusting tools (operations not exactly alike)	4.97	7.50
Turning end for end and handling	...	1.26
Extra work and lost time (including handling)	5.28	...
Total time	43.25	30.23‡

sis. In another case tasks were worked out in classes of work that at first thought would seem not susceptible of scientific analysis, viz., the reading and studying of scientific text. In both instances the work was carried out by Mr. Hollis Godfrey, who was at the head of the department of science in the institution referred to.

For a period extending over three years studies were made on the times taken by the slow, the quick, and the average boy and girl, to perform the routine experiments in the chemical laboratory, and out of some seventy tasks set on the basis of these tests, only three were found to be too long for the average student. The tasks were figured with an allowance for discussion of work by instructor and another allowance for writing out notes so that the slow student was required to devote extra time to his work. One of the assistants was given the function of seeing that the chemicals and supplies were provided for each exercise to avoid delay on that account.

* Making one rough cut and one finish cut at same feed as for rough cut.

† Making two finish cuts at less feed than for rough cuts.

‡ Includes allowance for lost time and delays.

For the setting of tasks for reading or studying scientific text, 100 pupils were timed to find how long it took them to read a certain number of pages for the first time, the second time, and the third time, it having been found that three readings were necessary on an average to assimilate matter of this character.

For other classes of study, such as the reading of literature or the reading of history, a fewer number of readings would naturally be required and a different time per page.

For mathematical calculations, such as slide rule work and compiling of tables requiring multiplication and division, I have found it possible to set tasks in my office, paying for this clerical work in accordance with the actual amount of work accomplished.

These illustrations are cited simply for the purpose of indicating the possibility of setting tasks for work done with the brain alone as well as that done with the hand or the machine.

If I am correct in my criticism, that different lessons and courses in different departments permit a wide range in the amount of work required by the students, then the problem is worth consideration. Like any problem worth studying, the solution cannot be given offhand, and only general suggestions can be made as to the method of handling it.

In our schools and colleges more attention is being given to the personal element. In our city schools we now frequently find a vocational department. It should be possible to take another functional step in the direction I have named by delegating to a definite group of men the function of studying and comparing the work required by the different courses and departments. To do this properly, a scientific analysis must be made and time observations taken upon students. Then with the advice of the individual instructors the courses could be definitely planned. Just as the task time fixed for certain machines and men in one shop may be applied to similar machines and men in another shop, so having once determined the unit times for a certain course, the same units could be readily adapted to a similar course in other schools.

In making this suggestion, I am well aware that I shall be met with the stereotyped objection that "you can set tasks for other kinds of work but you can't set tasks for this," but from my experience I know that it is possible to make a scientific analysis and to set tasks in practically all kinds of work. It may not be economical to set tasks in all kinds of work—in cases for example where the operation is repeated only occasionally. If a course of study or laboratory or shop work is outlined simply for a single year and is not to be repeated, there may be a question whether the setting of tasks is worth while. If, on the other hand, as is usually the fact, the same course is repeated year after year with only a few changes, that can readily be provided, for if the analysis of the operations has been properly made, the scientific layout of the work is practicable.

IMPROVEMENT OF ELEMENTARY PHYSICS TEACHING.

BY J. A. RANDALL,

Instructor in Physics, Pratt Institute.

The article of Professors Franklin and MacNutt and the editorial in the March BULLETIN calling for a discussion of the elementary physics courses were timely and the suggestion there given to publish in the BULLETIN a summary of what constitutes "good practice" in physics instruction should receive ready response. We need very much to get together in this matter and, if that is our desire, it is surely folly to cry fool at those who see things differently from us. It may be safe to mention a physics syllabus in print but in conversation with a physics teacher it is hardly wise. To a physics teacher, a syllabus is a device that someone wants to inflict upon others but never expects to use himself. It is a desiccated skeleton of a course which someone ships in a mailing tube to the fellow with too little wit to make an outline for himself. The physics teacher wonders how a pedagogue so lacking in capacity as to be unable to make an outline can be expected to clothe such dry bones with flesh and infuse vitality and life into such a thing.

What we want is to see the teaching of the other fellow just as it is. We want all the vitality and life there is in his suggestions. We want to catch the spirit in which things are said and done. There is a human factor in teaching and let's recognize it. One might easily get the impression from the number of historical experiments in our text books that physics laboratory work is intended to impress the student with the idea that history repeats itself, but a glance at student data on such experiments dispels that notion. Laboratory instruction is being given in a very different way, I

suspect, but no one has a word to say about it, except Professors Franklin and MacNutt.

The immediate need is to know what the other fellow is doing. And by that I mean that we need to know in detail how certain difficulties are overcome and how troublesome conceptions are given. University physics teachers have a medium of exchange for research discoveries and have fallen into the unfortunate habit of always talking about research work when they are visiting one another and when at meetings. This always gives the impression that our physics professors have adopted research as a life work rather than teaching. While this impression is not fair it still remains true to the detriment of education that there is no organization or medium of exchange in which the teaching of college physics is regularly treated.

In using the columns of the BULLETIN for this purpose it must be remembered that anything advocated by this society will be open to the charge of being in the interest of engineering education rather than pure science education.

Since there are so many conflicting interests shaping the instruction in our various institutions, no syllabus will fit in the classes of a considerable number. Under present conditions each college must choose from the published laboratory exercises or devise its own experimental work for its students. The new experiments do not become known unless someone in the college publishes a text. This is a slow way of circulating teaching inventions and probably is one of the causes of the prevailing impressions that college physics is poorly taught. We do not know what the other fellow is doing and we consequently assume that he is doing only what current text books suggest.

As chairman of the Committee on the Improvement of Physics Teaching of the American Federation of Teachers of the Natural and Mathematical Sciences, the writer recognizes that in the recent numbers of our educational journals the aims and ideals of physics teaching in secondary schools have been wisely and ably expressed. It has been pointed out that

our type of student is rapidly changing, the caliber of teacher is changing, and the science itself is increasing in content and is rapidly altering in the importance and number of its applications.

If a student goes into an electrical laboratory, it is obviously for electrical experience. If the student is in a public high school the probability is, that he will never go to college for further electrical training. Then he needs electrical experience as closely related to his life as a citizen as possible. This calls for instruction in electric lighting, wiring, the telephone, telegraph, and other common appliances or if the student is a girl, with electric cooking devices. It is possible with these articles to give exercises which teach all of the electrical theory commonly taught, and at the same time to associate it with articles commonly seen and spoken of in daily life. Since we are more likely to forget those things which are not associated with recurrent experiences, to use commercial articles is a legitimate teaching device. As with any other good thing, there is danger of commercial articles being used in ways that are not educationally good and then teachers may try to justify poor work by saying that the articles used are commercial. This danger is no greater than that the present type of text book will be abused.

A second tendency which is growing is to discontinue using small quantities of material with which to experiment. It is good psychology to give a boy, when he is studying force experiments, apparatus of a size to command his respect and requiring weights that give him an appreciable physical reaction. If a boy loads a crane with 500 lbs. of cast iron weights before investigating the forces in its members the chances are good that he will take off his coat in the process. That act is a pretty good indication that he recognizes the problem before him as a real one. Boys prefer to use a block and falls that they know is like one they have seen on a ship or in a barn rather than do experiments on a toy set of pulleys. Children, like grown ups, want the real thing when they can get it.

A third tendency is to discontinue in elementary classes the determination of physical constants. It is to be presumed that the object in having an elementary student do such an experiment is to teach him what the constant is, what units it is expressed in and to give him an idea of the "experimental method." The constant is better taught by assigning laboratory exercises in which the constant is used. The young student manages to violate all the recognized principles of experimental method, and makes strenuous efforts to establish new ones. Many college men have advised secondary teachers to discontinue the attempt to teach the scientific method in the high school as there seems to be no great success in making the college student grasp it. I believe this advice is being followed, but I wonder if the college man can solve his problem so easily?

The secondary teachers in our larger cities have seen the need of a change and have asked freedom from college entrance requirements and from state syllabæ to work out a course different from the type given in the freshman year in college and engineering school. Grandpa's coat cut down never fits Willie if you ask the boy. The imitation of college work in preparatory school hurts both institutions. It is not what the young boy needs and when he does enter his freshman course he thinks he knows it all if he has had "College Physics."

The historical course and the systematic course describing the field of a particular science in a *comprehensive* way has no justification in the high school. What is its place in elementary courses in college?

Just now the Physics Committee is devoting its efforts to collecting apparatus designs of pieces which yield *quantitative* experiments applying the more important physical principles. J. M. Jameson is publishing in the current numbers of *School Science and Mathematics* a detailed statement regarding some of the more simple exercises in use in Pratt Institute. The Committee believes that all good exercises and apparatus that are found valuable in any school should be described in our journals and in government bulletins.

Blue prints showing the design of any pieces which come to the attention of the committee are being prepared. Some are now ready for distribution and will be sent upon application.

Ultimately the committee hopes to collect enough information about what is being done that stands the test of inspection in the light of our new ideals to enable us to say what the "best practice" is in all matters pertaining to secondary physics instruction. When we really know what new things are being done, we hope to advise a policy that will enable teachers' organizations to accelerate the evolution of science teaching.

President H. S. Pritchett of the Carnegie Foundation in his 1910 annual report has correctly said that we will not have competent teachers and teaching in either secondary schools or colleges until we have in every university technical courses for the preparation of teachers. He correctly says that teachers' courses under University men have been too much effected by the research atmosphere and too little by what constitutes sound educational work with students of different types and ages. The committee has not as yet seen any way to help bring about this change in the curricula of our universities. It is to be hoped that our summer courses for teachers may lead to such regular term courses.

The committee has undertaken the work of circulating apparatus designs and teaching ideas with the hope that we may be able to provide a continuous supply of new material from which we may occasionally select fresh raiment for our dry bones. A good teacher is always versatile. This plan puts something up the sleeve of the physics teacher.

It may be true that in our colleges the closet door is wide open and the spot light may be showing the articulated vertebræ. The sort of thing that will help most is not to argue but to tell the other fellow what you are doing that is worth while.

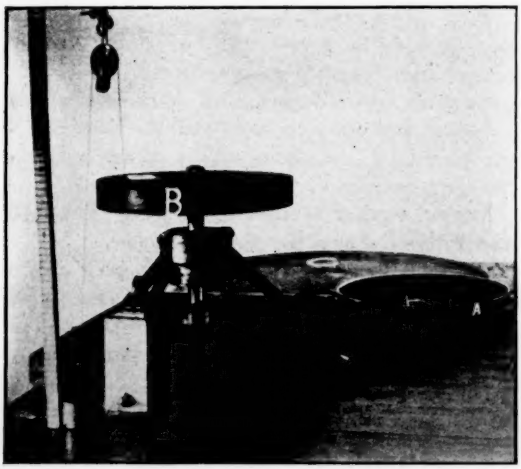
The first paragraph of the article of Professors Franklin and MacNutt closes with the sentence: "Half a hundred exer-

cises of this general character have been devised and the response of the young man is something good to see." I vainly read the remainder of the "first paper" in the desire of learning something more of these exercises. I hope to find in the succeeding papers detailed accounts of these interesting exercises, so that we may try them on our students without repeating all of the labor of invention and design.

Some of the simple devices are most valuable. In the Pratt Institute Physics Laboratory we have difficulty in teaching the idea of moment of inertia. We are doing two exercises using the apparatus shown in the figure. The following direction sheets from "Physics Laboratory Notes," copyrighted, 1911, by J. M. Jameson, are written for men of about the age of college sophomores and approaching the instruction from about three years of commercial life.

EXPERIMENT 18–4. THE RELATION OF ANGULAR ACCELERATION TO TORQUE AND DISTRIBUTION OF MASS.

The apparatus consists of a heavy fly-wheel arranged to rotate on a vertical shaft. The torque is applied to a drum keyed to the shaft, by a



cord leading over a small pulley and carrying a scale pan. Acceleration is computed from the distance this scale pan weight descends in a known time. For convenience in computation, distance is read from a vertical scale graduated in $\frac{1}{10}$-ft. divisions and the drum is exactly 1 ft. in circumference. When the scale pan descends 1 ft., therefore, the fly-wheel makes one revolution, etc. The pulley is as light and frictionless as possible and the thrust of the shaft carrying the fly-wheel is taken by a cone bearing.

Before taking data, flood all bearings with oil and correct for friction by attaching an extra weight to the cord just sufficient to maintain uniform motion when the apparatus is started.

Three fly-wheels are to be used with the apparatus, each a disk of uniform thickness. *B* is the same diameter as *A* but twice as heavy, *C* has the same weight as *B* but is twice its diameter.

Apply scale pan weights as directed and complete the following table of data:

(Distance recorded should be the average of several independent determinations.)

Fly-wheel.	Weight of Scale Pan (W).	Time in Secs.	Distance.	Linear Acceleration of Scale Pan (a).	Force to Scale Pan $\left(F=\frac{W}{g}a\right)$.	Torque $(W-F)X$ Radius Drum.	Angular Acceleration of Fly-wheel.
A .....lbs.							
B .....lbs.							
C .....lbs.							

Plot curves from your data, showing the relation of angular acceleration to torque (abscissa) for each wheel. Plot the three curves on the same sheet and to the same scale.

Conclusions regarding relation of angular acceleration of a fly-wheel to torque applied?

Determine from your curves the torque required to give *A*, *B*, and *C* the same angular acceleration (any convenient value). The conditions for accelerated motion of rotation may be expressed: Torque $= K \times$ angular acceleration, in which K is a constant which expresses the *rotational inertia* of the body.

Substitute the above values for torque and angular acceleration, and determine K for each wheel. Compare the values for A and B and the values for B and C.

Is K the same as the mass? What general effect has distribution of mass upon K?

Compute the moment of inertia of each wheel. Compare these with the values found for K.

State in general terms the factors which determine the rotational inertia of a body.

Upon what does the torque required to set a body rotating at a given speed depend?

Experiment 18–8. Energy of a Rotating Fly-Wheel.

When the weight W of the apparatus in Exp. 18–4 has descended a distance of L ft., the work done on the apparatus is WL ft.-lbs. By the law of conservation of energy, this work has been expended against friction and thus dissipated as heat, or is stored in the rotating wheel and in the moving weight.

Or WL = energy expended against friction + kinetic energy of fly-wheel + kinetic energy of moving weight.

The object of this exercise is to measure each quantity in this equation in foot-pounds and check the application of the equation.

Note: (*a*) The cord over the drum must end in a loop passed over a small pin so that the torque is removed when the weight has descended L ft.

(*b*) Friction should be measured at the circumference of the drum.

(*c*) The velocity of the weight when released is to be determined from the time in seconds required by the fly-wheel to come to rest after the torque is removed and the number of revolutions made in this time. These will give the velocity of the drum in revolutions per second when the weight drops off, and from this and the diameter of the drum, the velocity of the weight in feet per second may be found. The kinetic energy of the weight may be found from the formula $Wv/2g$.

(*d*) Kinetic energy stored in the fly-wheel = work done against friction in coming to rest.

Care must be taken in measuring friction. Friction of the pulley over which the cord runs is included in the computation of "work against friction," while the torque acts, but not in the value for friction used in finding the stored energy of the fly-wheel.

The report should contain all data required, and all computation with an explanation of the theory.

Addenda to report: The kinetic energy of a rotating body $= Wv_0^2/2g$, where v is the linear velocity at a point situated a distance equal to the *radius of gyration* from the axis.

Place $Wv_0^2/2g =$ to experimental value of kinetic energy of wheel and solve for v_0. From this value for v, and the speed as the torque was removed (see above) compute the radius of gyration for the wheel. Compute also the "equivalent mass" and the moment of inertia of the fly-wheel.

The committee is anxious to win the support of college teachers. I wish to make here an earnest appeal for contributions of apparatus designs and suggestions of any character which the readers of this BULLETIN feel would make the work more successful.

THE TEACHING OF ELEMENTARY PHYSICS.

BY R. F. DEIMEL,

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Professors Franklin and MacNutt in their "Notes on the Teaching of Elementary Physics"* hit Poor Teaching some well deserved and effective blows, but it seems to me that certain Straw Men were slaughtered in the combat. I want to champion the cause of these innocent victims.

Any method of teaching must depend primarily on its object, its purpose. If the purpose is not kept conspicuously in the foreground, the teaching is not a worthy cause of dispute. In the teaching of physics the object is to present facts, to show relationship among them, and, not less, to give the student the ability to deal with abstractions. (These are not arranged in order of importance.) The "Notes" apparently disregard the third object: witness—"everything should be omitted . . . which either is not familiarly known . . . or likely to become familiarly known to him as a plain man" (p. 404).

Before hastening to the attack I want to deny the existence of the "plain man" and of his relatives, the "man in the stree" and the "average man." These are merely euphemisms for a *fictitious* person of abysmal stupidity and violent hostility to the acquisition of new ideas. His counterpart in life is the untrained man whose vocabulary consists largely of such terms as "common sense," "natural," "reasonable," "practical." Processes of deduction and words of precise meaning are as yet unknown to him, so that when he begins the study of science, carefully framed definitions make his linguistic wave of the hand impossible. He, in his youth and naiveté, thinks that a sausage-meat grinder is not a lathe nor an ore crusher, and that a loom is not a printing press nor a

* BULLETIN, Vol. II, No. 7.

planimeter. It might be worth while speculating whether, in his maturity and sophistication, he ponders on the cost of a stone wall "when . . . energy costs nothing except the '*expense*' of gathering it together and applying it."

But to our Straw Men. Surely Professors Franklin and MacNutt do not know of any book in which an entire chapter contains nothing more than the bare statement "Energy can neither be created nor destroyed." Although their statement (*b*), p. 400, is an excellent illustration of what is implied by conservation of energy, the very form of the generalization opens a new field to the young student and introduces to him one of the greatest abstractions in science: 'abstractions,' because energy, notwithstanding its measurability, is no more a concrete thing than, for example, justice, motion, capacity.

While I agree with the authors that statements of the Second Law of thermodynamics better than the one criticised by them, p. 402, are possible, I cannot see absurdity in the phrase "flow of heat." If this phrase is absurd, what is to become of such expressions as "conduction of heat," "electric current," "light-wave," "quantity of heat," "lines of force," "force," and particularly of the symbol dq/dt? Nobody ever saw force, electricity, potential energy, as entities. Why is it absurd to say that if the end of a poker is put into a fire the handle eventually becomes hot? Why is it wrong to invent a noun to associate with the verbs "to push," "to accelerate," "to stretch." What of the equivalence of complexes which are not exactly conservative?

It may be a matter of belief, but it is not necessarily a fact that *the* "fundamental fact concerning fluid pressure is that a fluid at rest exerts a normal force upon an exposed surface." Are those who want to regard hydromechanics as well as elasticity as the study of internal stresses not to be allowed this liberty—or perhaps license? As for experimental proofs, it is as easy to show the absence, or smallness, of shear stress in a liquid by splashing it about, pouring it, etc., as to prove the absence of tangential forces on immersed surfaces. I object to the possible implication that a fence has only one side.

A characteristic of the man who has not studied science is that he attaches no importance to the obvious or apparently trivial detail. It is our duty as teachers to instil in him a proper respect for the smallest fish in the net; occasionally, however, in concentrating on the whale he sees the minnow out of the tail of his eye. The Freshman, p. 404, probably thought the instructor a fool not to know that he—the Freshman—understood the coal was to be burned; in this case he was actually turned away from the obvious detail. It would be interesting to know what the vain attempts of the instructor were—did he ask what combustion is, what coal is used for, what we do with it and why? That Freshman would not have known less had he been heckled less. Why discharge "such" young men—one of them undoubtedly knew as much as his teacher.

I regret not yet having read Larmor's "Scope of Mechanical Ideas," but I know that, despite Larmor's exceptional ability, he can not invalidate Mach's remarkable discussion of force and mass. These discussions are opinions, points of view. Let me, to illustrate a point of view, attack the first paragraph, p. 406, which says, in effect,

(i) Define mass as measured by a balance scale.

(ii) Prove experimentally that the acceleration produced by a given force is inversely proportional to the mass.

Notwithstanding a hoary superstition to the contrary, a balance scale compares *forces* indirectly through moments; in a field of no force any two masses would balance each other. A spring balance, on the other hand, is at the very least as well adapted to the comparison of masses, because two bodies which, at any one place, have the same effect on it are of equal mass. When we consider that unequal weights may balance each other but that unequal weights cannot produce equal stretches, it appears that the idea of the spring balance is far simpler than that of the lever balance. However, neither can be used to define mass *unless we postulate* (ii); even then it is impossible. But never mind this. What is mass? We cannot see it any more than we can see heat. We know—and so does

our "plain man"—that scales measure *pulls*. How can we keep within his intellectual mud-puddle (p. 404, 1st paragraph) and still tell him what mass is? Quantity of matter? Hardly. If statement (ii) be changed to read:

(iii) The mass of a body on which a given force acts is inversely proportional to the acceleration produced, we have here a quantitative definition of mass and a suggestion for measuring force. The *Ding an sich* has no interest for us. While both (ii) and (iii) have the defect of presupposing a "given force," I think (iii) is immeasurably superior to the combined (i) and (ii): it is simpler, more complex, more concrete, less tangible, more and less philosophical, and more—impossibly less—meaningful.

In the division "Machines and the Idea of Energy," p. 406, Professors Franklin and MacNutt presumably meant that machines include mechanisms—devices for transmitting and transforming *motion;* an explicit statement to this effect would have done no harm. If they meant more, more still remains to be said; at any rate the point is well taken. But it is to be doubted whether the section "Machines" would have been written in just that way if the authors had read Fritz Mauthner's "Kritik der Sprache," his "Wörterbuch der Philosophie" or even his brochure on Aristotle.

I have taken the liberty to criticize—perhaps harshly, but by no means intentionally so—certain minor features of the mechanism of the reform proposed by Professors Franklin and MacNutt. But everybody must be intensely interested in the reform itself, and must be in full sympathy with the splendid spirit of the "Notes." It is easy to predict that their effect will be neither small nor unimportant.

"Algebra should be reduced to a minimum in the study of elementary physics. Only the most fundamental relations should be expressed by formulas, and purely algebraic developments growing out of these fundamental expressions should be omitted."

"Bring' vor, was wahr ist;
Schreib' so, dass es klar ist
Und verficht's, bis es mit dir gar ist!"

COLLEGE NEWS.

Carnegie Institute of Technology.—The name Carnegie Technical Schools was changed to the Carnegie Institute of Technology on April 20, 1912, and the institution received a charter of incorporation from the state of Pennsylvania, with the power to confer degrees.—Viscount Chinda, the new Japanese Ambassador to the United States, was honor guest and principal speaker on Founder's Day, April 25. Included in the program of the day was the laying of the corner stone for the School of Applied Design, in connection with which the art students presented a pageant in costume representing the five periods in the history of art.—Dean John H. Leete, of the School of Applied Science, has recently been appointed a member of the Morals Efficiency Commission by the Mayor of Pittsburgh.—Professor H. S. Hower, of the department of physics, has been elected chairman of the newly organized Pittsburgh section of the Illuminating Engineering Society. —The first group of engineering students were scheduled for their field work at Camp Louise Carnegie in April. This camp, named after Mrs. Carnegie, was formerly a farm of 750 acres which Mr. Carnegie owned at Garver's Ferry on the Allegheny River, 26 miles from Pittsburgh.—According to a preliminary estimate, approximately 210 students will finish their courses this year and be graduated in June.—The United States Government now has under consideration the transfer of its Bureau of Mines in Pittsburgh from the present location at the Arsenal Grounds to a site adjacent to the Institute.—The department of mechanical engineering has just received a standard four-cylinder automobile chassis with complete equipment, to be used for indoor tests and for road tests.

University of Illinois.—Dr. H. C. Bumpus, business manager of the University of Wisconsin, addressed the instructional

staff and the students of the University of Illinois on April 22. His subject was "Some Methods That Have Been Tried in University Business Organization."—Professor F. O. Dufour, of the department of civil engineering of the University of Illinois, recently addressed the faculty and students of the Iowa State College on "European Bridges."—Work has been commenced upon the construction of the new ceramics and mining engineering laboratories of the University of Illinois. These buildings are to form a part of the group of engineering buildings to be located upon ground east of Mathews Avenue, which has recently been acquired by the university. The contracts for the new transportation building and the locomotive-testing laboratory will soon be let.—The second exchange lecture with Purdue University for the year was delivered before the students and faculty of the College of Engineering of the University of Illinois on April 25, by Professor R. G. Dukes, of the department of applied mechanics. His subject was "Recent Discoveries in Physical Science and their Bearing on Engineering Problems."—Professor F. M. Mann, head of the department of architecture of the University of Illinois, delivered a lecture on April 26 before the St. Louis Architectural Club on "The Small House."

University of Maine.—Work has been started at the University of Maine on plans and specifications tending towards the installation of a plant for the purpose of generating current for lighting and power purposes about the university buildings. The plant as proposed will be run in connection with the present heating plant, and all exhaust steam from the engines will be used for heating purposes, thereby supplying current at a minimum cost.—The senior students in the department of chemistry of the University of Maine started Wednesday, April 17, on a trip to Waterville, Lewiston and Portland. The object of the trip is to familiarize the men with the factory conditions of those industries in which considerable chemistry is involved. Mr. Buswell, instructor

in industrial chemistry, is directing the trip.—A petition has been circulated among the chemists of Maine and sent to the council of the American Chemical Society asking that authority be given for the formation of a Maine Section of that Society with headquarters at Orono. This section will include chemists from all parts of the state and will meet several times a year to discuss those problems and industries of most interest to the chemists of Maine.—At the University of Maine summer term, work will be given in courses in two departments of the College of Technology; Chemistry and Mechanical Engineering. Additional information regarding these courses may be had by sending to the secretary of the university for a Summer Term Bulletin.—Dean H. S. Boardman, of the College of Technology, University of Maine, recently lectured at Belfast on the subject: "Conservation of the Water Powers of the State of Maine." The lecture was given under the auspices of the Belfast board of trade and was attended by over two hundred people.

Missouri School of Mines.—The annual commencement address of the Missouri School of Mines will be given by James R. Finlay, of New York City. Exercises will be held on the morning of May 31. The graduating class numbers forty.—Owing to the continued demand from mining students, mine managers and superintendents, graduates and undergraduates of engineering schools, and science teachers, the School of Mines and Metallurgy announces a six-weeks Summer School beginning June 3, 1912. All of the courses will be given in the laboratories at Rolla.

Pennsylvania State College.—On May 1 a steel tower, two hundred and three feet high, was completed and given to the college by the class of 1912. The structure is for the college wireless station which has been in active operation now for two years.—The department of electrical engineering has received a specially designed harmonic set, manufactured by the General Electric Co. It consists of three 3-phase alternators, the fields of the three machines being mounted on the

same shaft. The largest of these generators is a 60 cycle machine, the second 180 cycles, and the third 300 cycles. The pressure waves developed by all these machines or by any two of them may be superimposed, and the waves themselves may be displaced by any desired amount. The harmonic set, in connection with a three-element oscillograph, provides equipment for exhaustive study along certain lines of alternating-current theory not found in any other college electrical engineering laboratory in this country. This equipment is the second of its kind that has been manufactured; the first is the possession of the electrical testing laboratory in New York City.—Work has begun on the foundations of a new building to be known as the Engineering Extension. It is expected that the building will be ready for occupancy in the fall. In it will be placed the laboratories of highway engineering, cement testing, electric furnaces, hot-blast heating system, milling, and possibly part of the testing of materials laboratory of the mechanical engineering department. The building is the first of four units that will be erected as additions to the engineering group.

University of Pittsburgh.—Professor H. J. Ryan, head of the department of Electrical Engineering at Leland Stanford University, lectured before the students of the School of Engineering on April 29 on the "Los Angeles Aqueduct." Before the lecture Professor Ryan was entertained at luncheon by the Chancellor and the heads of departments of the School of Engineering.—The last of the series of lectures on sanitation and public health was given on May 14th by Mr. James T. B. Bowles, physiologist, in charge of water supplies and filtration plants of the Panama Canal, on the subject "Methods and Results of Sanitation, Isthmus of Panama."—The university will be represented at the National Irrigation Congress by Professor Morris Knowles, who is a member of the executive committee of the Congress.

Stevens Institute of Technology.—The famous "Stevens Castle" which stands on a bluff about one hundred feet above

the Hudson River and almost directly opposite Fourteenth Street of New York City, has passed into the possession of the Stevens Institute of Technology and is now used as a "home for many students and as a gathering place for undergraduates, alumni, and faculty." It is pecularly fitting that this building, "the home of the famous engineers of the Stevens family and the place which saw the birth of many inventions that have been of great benefit to mankind" should become a working part of the college of engineering which bears the name of the family. It is expected that the Stevens Institute will soon acquire an additional tract of land south of the "Castle," when it will have an ideal site for a college of engineering.

University of Tennessee.—A summer school of engineering will be conducted for six weeks, June 18–July 26. While all the general engineering subjects of the first three years will be offered, particular attention will be given to water-power engineering. Much water power is being developed at the southern end of the Appalachian Mountain system, giving impetus to the study of hydraulics in the University of Tennessee.—Recently a holiday was declared for all engineers to build a campus road of much importance in the development of the engineering departments. Students and professors worked side by side with pick and shovel. The young ladies of the domestic science departments furnished the noonday lunch. At 8 P. M. all the workers enjoyed a banquet.